Additional photographs, taken with longer exposures, and covering a greater range of the spectrum, are required before it can be ascertained exactly how much of the detail of the spot spectrum is due to magnesium hydride, but there are indications that several hundreds of the umbra lines will be accounted for. The interpretation of the spot spectrum will evidently be greatly simplified by the elimination of the part due to the flutings, which can be made with greater certainty now that their origin has been traced.

The identification is also of interest as supporting the view that the vapours in spots are at a relatively low temperature. The special strengthening of the flame lines of metals in spots determined independently by Professor Hale and myself, and the subsequent detection by Professor Hale of the extreme red flutings of titanium oxide, however, had left little doubt on this point.

As a great number of the umbra lines under consideration were found by Professor Hale to correspond with very faint solar lines tabulated by Rowland, it must be inferred that magnesium hydride not only occurs in spots, but in a less degree in the general reversing layer of the Sun.

I have great pleasure in expressing my obligations to Messrs H. Shaw and E. J. Evans for able and unstinted assistance in carrying out this preliminary investigation under somewhat difficult conditions.

The Spectrum of Mira Ceti in December 1906, *as photographed at Stonyhurst College Observatory.*

Rev. Walter Sidgreaves, S.J.

The short series of photographs of the spectrum of *o* Ceti obtained during the unfavourable weather of December last consists of 18 plates on eight nights between December 1 and the following January 3. Of these, 13 plates are by the Thorp objective prism and 5 by the Hilger compound prism. Both prisms give only short spectra. Those by the objective extend well beyond the head of the hydrogen series of a star of the 3rd magnitude, with a length of 22 mm. between H_ν and the red end limit. This limit is a little beyond H_β, for the camera cannot conveniently be adapted to the focal curve of the green and yellow rays. The compound prism stops the violet light by absorption, and the spectrum reaches H_ϵ only of the brighter stars. On the other hand, it extends to the yellow sodium lines on an Edwards isochromatic plate, all in good definition, but covering only about 16 mm. on the plate. This prism was the only one in use at the maxima of 1897 and 1898, and the five plates exposed during the recent exceptionally bright maximum serve for comparisons with those of the earlier dates. They are all that can be desired in definition; but unfortunately no one of them was sufficiently over-exposed (slowly trailed) for

a comparison with the hydrogen spectrum given by the objective prism, as will be seen later.

The line-absorption-spectrum of the star's light in 1906 is substantially the same as in 1897 and 1898; but the bands are very much weaker—quite enough to account for the increase of light at this bright maximum. The bands in the neighbourhood of H_β and H_γ are nearly, perhaps quite, absent on our plates of 1906, and will be referred to immediately in connection with the bright hydrogen lines.

The remarkable change in the hydrogen spectrum, noted in the intensity of H_β by all spectroscopic observers of Mira, is accompanied by a decided change in the relative intensities of H_γ and H_δ. On the plates of 1897 and 1898 the intensities of these lines are quite equal, without allowance for the prismatic absorption at H_δ, or the sensibility curve of the film; and on the same quality of plate (Edwards) in 1906 H_γ is distinctly the stronger.

But whether these changes are to be attributed to an altered condition of the star's hydrogen envelope, or to a diminished absorption in the regions of the lines, cannot yet be determined with certainty. There is, however, some evidence on our spectrograms that the changed appearance of H_β is mostly due to the changed condition of an absorbing atmosphere. The bands in the neighbourhood of H_β [numbered 12, 13, 14 in our tabulations of 1897, *M.N.*, lviii. 348], including the one covering the line, were very strong in 1897, and do not appear on our plates of 1906, but in their stead their sharp edges on the more refractive sides are strong, stout lines. Also the same absorption-bands are weaker, and H_β is stronger on the plates of 1898 than on those of 1897.

The change in the relative intensities of H_γ and H_δ may be accounted for on the same lines, but evidence is wanting on our plates, owing to the weak condition of the absorption-spectrum near H_δ through loss of light in the prism. The objective prism shows a weak absorption-band about $H\delta$; and if this was, like the rest, stronger in 1897, we should conclude that the change must be attributed to the radiation of the origin rather than to external absorption. The same prism has shown that though apparently weaker than H_γ, H_δ still claims to be the strongest of the series. For on December 1 plates were simultaneously exposed on both spectrographs; and while H_δ appears weaker than H_γ by the compound prism, it is quite its equal by the objective prism, without allowing for the less sensibility of the plate to the $H\delta$ radiation.

Other peculiarities of the hydrogen spectrum have been brought out at this maximum by the objective prism. We have now a photographic record of the series from H_β to H_σ, in which there is no sign of H_ϵ, while H_ζ is quite strong. But the three following lines H_η H_θ H_ι, although they are conspicuous bright lines on the stronger photographs, are out of proportion weaker than H_ζ, their intensities following the natural order of sensibility, decreasing with shorter wave-lengths. The next nine lines are, again, out of proportion weaker than the preceding three. They are extremely

feeble, and are seen only on the strongest photographs, numbered 1983, 1990, and 1992, one of December 12 and two of the following January 3. But they are all easily pointed with a low-power micrometer eyepiece, especially on plate 1992; and they are all bright lines.

The following lines have also been noted as more probably fine bright radiations than thin separations of very broad absorptions, at λ 3843, 3853, 3862, 3872, 3893, 3905.

A special search has been made for the bright lines quoted by Plaskett,* but without any satisfactory result. Our spectra are probably too small. But three lines found at λ 4106, 4119, 4137, agreeing with three of Plaskett's lines, might be called possible bright lines.

But the most remarkable feature brought out by the objective prism is the character of the hydrogen lines. Mr Plaskett, of the Dominion Observatory, has observed on his plates an asymmetrical widening of the lines on the red side, which was more marked on the denser photographs: "No trace could be found of Campbell's triple formation. . . . The lines were, however, in the majority of the plates, unsymmetrically broadened with respect to the actual centre of intensity determined from the tips of the emission lines. . . . . And this asymmetry became more evident the more intense became the line." †

On all our plates by the Thorp objective prism, excepting two of weaker photographic intensity, H^{δ} appears greatly widened on the red side, shading down, but terminating in a comparatively strong bright line; and the same feature is seen in H_{γ} but with less dispersive separation; also on three extra-dense impressions the same is seen in H_{ζ}.

In all cases the features are greatly exaggerated by over-exposure, and there is some evidence of their being more pronounced when the definition is less perfect. On this account, and still more on account of the total absence of apparent asymmetry of the lines on the series of plates by the Hilger compound prism, the writer has long hesitated to put the facts on record. But, after many repeated examinations of both series of photographs, he has come to the conclusion that they cannot be attributed to any photographic freak. And in favour of this conclusion it must be observed, first, that the absence of asymmetry on the photographs by the Hilger prism is quite explained by the great prismatic absorption of the H_{δ} region, and our unfortunate want of a sufficiently over-exposed plate to bring out the weaker extension of the line; while the dispersion at H_{γ} would be too small to be effective. Secondly, that the features cannot be attributed to inferior definition is satisfactorily established by two photographs of December 10, although at first examination these were the plates that threw doubt upon the reality of a stellar origin of the phenomena. On the first of these

* *Spectrum of Mira Ceti*, by J. S. Plaskett, Roy. Astr. Soc. of Canada, Jan.–Feb. 1907.

† *L.c.*, p. 52.

the photographic intensity is very great with poor definition, and the red-side wing terminating in a bright line is seen very clearly in H_γ H_δ and H_ζ. On the second, the impression is weak with perfect definition, and there is little or no sign of the wing even in H_δ; but alongside of this line there is a feeble but quite distinct bright line in precisely the position of the bright line termination of the wing on the preceding plate: the exposure was just enough to bring out the stronger edge of this extension, leaving the weaker interval untouched; and the same condition of things was found on the other excepted plate of December 1. Again, the measured intervals between the strong centres and the bright line terminations of the wings in H_γ H_δ and H_ζ agreed in showing the same spectral interval of 5-tenth metres.

Our photographs therefore go to confirm Campbell's observation of the triple formation of the hydrogen lines, but enormously developed; and the Dominion plates with a prolonged exposure might have provided additional evidence with further details.

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Note on the Visual Spectrum of Mira Ceti in December 1906.
Rev. A. L. Cortie, S.J.

The spectrum of Mira Ceti was examined visually with a Maclean star-spectroscope attached to the Perry Memorial 15-inch equatorial on the evenings of Dec. 6 and Dec. 9. The visual magnitudes of the star on these two dates have been kindly furnished by Colonel E. E. Markwick, from means of observations by members of the variable star section of the British Astronomical Association, as 2·07 mag. on Dec. 6 and 2·00 on Dec. 9. The maximum intensity in the visual spectrum on these dates was unmistakably in the red and the orange part of the spectrum. The most brilliant part of the spectrum was the bright background or band which began sharply at the edge of Duner's second band at approximate λ 6164 and shaded off towards the violet. The red background to the Duner's bands beginning at approximate λ 6493 and 6164 was very brilliant. The bright space between these two absorption-bands had a central maximum of brightness. With regard to the brilliant space beginning at λ 6164, the edge was so sharp and bright and the intensity faded so perceptibly towards the violet that visually it appeared as a bright band. At least it is safe to affirm that the maximum of brightness of the star was in the region λ 6164–5958. In the telescope on Dec. 6 the star was distinctly golden in hue, and was much redder than Aldebaran when compared with that star on Dec. 9. These visual observations of the spectrum are confirmed in all details by four plates taken with the Hilger compound prism on the nights of Dec. 6, 9, 13, and 14. The plates were stained with pinachrom; and although, as was proved by a trial plate taken of α Cygni, the effect of the dye is to give an exaggerated importance to the orange